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Comment [AJ1]: We refer to figure D5 for this instead

1. INTRODUCTION

This Attachment was prepared in support of Excelsior Mining Arizona, Inc.'s (Excelsior's) Underground Injection Control (UIC) Permit application to the United States Environmental Protection Agency (USEPA). Excelsior is applying for an area Class III UIC permit to install a wellfield for in-situ recovery (ISR) of copper at the Gunnison Copper Project (Project), located in Cochise County, Arizona.

This attachment provides information to support Excelsior's request for an aquifer exemption for the Project. Attachment S-2 is provided as a supporting reference document.

2. EXEMPTION CRITERIA AND CONSIDERATIONS

The criteria applicable to Excelsior's aquifer exemption request are Chapter 40 of the Code of Federal Regulations (CFR), 146.4 (a) and (b)(1). Specifically, the aquifer:

> *(a) does not currently serve as a source of drinking water; and*
>
> *(b) cannot now and will not in the future serve as a source of drinking water because it is mineral, hydrocarbon or geothermal energy producing, or can be demonstrated by a permit applicant as part of a permit application for a Class II or III operation to contain minerals or hydrocarbons that considering their quantity and location are expected to be commercially producible.*

2.1 Source of Drinking Water

~~The aquifer does not currently serve as a source of drinking water. As shown in Attachment B of this UIC Permit Application, there are no active, producing water supply wells within one mile of the Project boundary.~~ The aquifer does not currently serve as a source of drinking water. As shown on Attachment B of this UIC Permit Application, there are no known, active, producing water supply wells within one-half mile of the Project boundary.

2.2 Commercially-Producible Minerals

The Project area contains commercially-producible grades of copper. A Prefeasibility Study (PFS) of the process and infrastructure design, capital cost, operating cost, and an independent Technical Report, compliant with the Canadian National Instrument 43-101 ("NI 43-101") standards for reporting mineral properties, was issued in 2014. The ~~P~~FS ~~is~~ was ~~currently being updated and will be re-issued by the end of 2016~~completed in early 2017 and has been provided to EPA.

Excelsior's Probable Mineral Reserve is defined from a copper resource estimate developed by Excelsior and an independent consultant in 2015. The estimation of copper resources within the proposed aquifer exemption area is based on 6,427 assay samples from 96 core and reverse circulation drill holes totaling 140,034 linear feet. Forty-two of the contributing drill holes were drilled by Excelsior during three drilling campaigns between 2011 and 2015. The remainder of contributing drill holes to the estimate were drilled by other companies between 1970 and 1997. Excelsior controls and has verified the historical drill data.

Table 1 below summarizes the reserve within the proposed aquifer exemption area. To create the reserve, the mineral resource estimate was constrained and evaluated in accordance with Excelsior's mining plan. The conservative estimate includes material from the Measured and Indicated categories of the mineral resource and excludes Inferred mineral resources. It does not include material from the sulfide zone, which is below the proposed aquifer exemption. It assumes the use of *in-situ* recovery as a mining method, which requires a wellfield (delivery and recovery wells) and pumps pregnant leach solution to an SX/EW plant to recover the copper. The boundaries of the Probable Mineral Reserve were defined using economic parameters. Excelsior developed a wellfield / production schedule for the Project. The mineral reserve estimate is the sum of the production schedule within the proposed aquifer exemption area.

Table 1: Mineral Reserve Within Proposed Aquifer Exemption

	Tons	**Total Cu %**	**Metal Lbs.**	**Recovered Metal Lbs.**
Total	**307,314,401**	**0.33**	**2,002,432,410**	**989,101,608**

The following sections provide additional information regarding the deposit, its mineralogy and geochemistry, and the proposed mining method.

2.2.1 Map and General Description of Mining Zone

The Project lies on the eastern edge of the Little Dragoon Mountains (Figure S-1). The Dragoon Quadrangle, which includes the Project area, has been described and mapped by Cooper and Silver (1964). Cooper and Silver's geologic map of the Project area is provided as Figure S-2.

The Little Dragoon Mountains are an isolated fault-bounded up-thrown block within the Basin and Range province in southeastern Arizona. The ages of the rocks range from 1.4 billion years ago (Ga) Pinal Group schists to recent (Holocene) sediments. The southern portion of the Little Dragoon Mountains consists predominately of the Tertiary Texas Canyon Quartz Monzonite (TQM), whereas the Pinal Group schists and the Paleozoic sediments that host the regional copper mineralization dominate the northern half.

The oldest rocks in the area, the Pinal Group schists, are composed of sandstones, shales and volcanic flows that have been metamorphosed to greenschist-amphibolite facies. The Precambrian Apache Group unconformably overlies the Pinal Group Schists and is composed of conglomerates, shales, and quartzite that were subsequently intruded by diabase sills. The Apache Group is then unconformably overlain by the Paleozoic rocks, including the Bolsa, Abrigo, Martin and Escabrosa Formations, that host the mineralization. Overlying the mineralized rocks are the Black Prince and Horquilla Limestones, Earp Formation and the Colina Limestone. Holocene basin fill has filled in the valleys.

The TQM is thought to be the source of the copper mineralization and is porphyritic with potassium feldspar phenocrysts from 1 to 10 cm. Livingston et al (1967) determined the age to be 50.3 ± 2.5 million years (Ma) and Reynolds et al (1986) list eight determinations ranging from 49.5 to 55.0 Ma. The intrusion outcrops to the west of the Project (Figures S-2 and S-3). Elevation contours of the top of bedrock are shown on Figure S-4.

The deposit is covered by un-mineralized basin fill, varying between approximately 300 and 800 feet thick in the Project area. A basin fill isopach map is provided on Figure S-5. The mineralized Paleozoic host rocks below the basin fill strike approximately north-northwest and dip 20^{o} to 45^{o} towards the east. Baker (1953) recognized three sets of faulting in the Johnson Camp area and similar faulting sets have been interpreted in the Project area. These faults include "Northeaster" (N 10^{o} to 30^{o} E striking with 70^{o} to 75^{o} dip to the SE), "Easter" (N 60^{o} E to S 60^{o} E striking faults dipping 30^{o} to 50^{o} S and higher angle reverse faults dipping 75^{o} S) and "Northwester" orientations (N 15^{o} W strike with steep E or W dip). Only minor displacements are thought to have occurred in the Project area. However, numerous sheared and brecciated faults generally filled with copper oxide mineralization cut through the deposit. Cross sections through the Project area are provided on Figures S-6, S-7, and S-8.

The geology of the Project has been investigated extensively by Excelsior. The results of the exploration program have been used to develop a geologic model that provides a three-dimensional representation of the formations, structural orientation, fracture intensity, and mineralization. The geological model, which was created by Excelsior and an independent consultant (Mine Development Associates), is based on 217 drill hole data points in the region totaling 245,509 feet, including 122 drill holes immediately in the resource area, 95 of which are within the Project area. The holes were drilled by either core, reverse circulation, or rotary drilling methods. Eight-six of the holes were drilled by Excelsior between 2011 and 2015. The rest of the drill hole data are historical and were acquired by Excelsior from the purchase of the property assets or from public records. Excelsior also used the Geologic Map of the Dragoon Quadrangle by J.R. Cooper to construct and validate the model.

A detailed discussion of the site geology and the geologic model is provided in Attachment F.

2.2.2 Mineralogy and Geochemistry of the Mining Zone

The Project is a classic copper skarn deposit (Einaudi et al, 1980 and Meinert et al, 2005). Skarn deposits generally form in calcareous shales and dolomites to limestones around or adjacent to the mineralizing porphyry. Significant mineralizing copper-rich hydrothermal fluids are focused along structurally complex and fractured rocks and convert the calcareous shales and limestones to andrydite-rich garnet assemblages near the intrusive body and to pyroxene- and wollastonite-rich assemblages at areas more distal to the stock. Retrograde hydrothermal fluids produce actinolite-tremolite-talc-silica-epidote-chlorite assemblages. The mineralization is typically pyrite-chalcopyrite-magnetite nearer the mineralizing porphyry and chalcopyrite-bornite more distally from the body.

At the Project, Paleozoic host rocks have been intruded by the TQM along the western margin of the deposit, forming copper skarn mineralization. High grade copper skarn mineralization is known to exist within the region and has been well-documented (Cooper and Silver, 1964). Similar mineralization has been successfully mined just 1.5 miles north at Johnson Camp Mine.

Within the Project area, the important mineralized host rocks include the Abrigo and Martin Formations and to a lesser extent the Horquilla Limestone and the lower parts of the Escabrosa Limestone. Mineralization is also found in the Bolsa Quartzite and Precambrian basement rocks. Copper mineralization is related to calc-silicate skarns that have formed within these carbonate rocks adjacent to the TQM.

The intrusion has formed wide zones of calc-silicate and hornfels alteration as well as extensive low-grade copper sulfide mineralization within the Paleozoic rocks. Metamorphic alteration grading outward from the stock includes; garnet-wollastonite-idocrase, forsterite-diopside, tremolite and chlorite-talc (Kantor, 1977). More specifically the Martin Formation grades from a wollastonite-diopside rich rock near the porphyry to a distal diopside-tremolite-actinolite assemblage and finally a dolomite. The Abrigo Formation has garnet-actinolite-epidote-diopside alteration with some biotite hornfels near the porphyry and grades to a distal tremolite alteration leading into un-metamorphosed limey shale. Quartz-orthoclase-carbonate ± magnetite and chalcopyrite veins are characteristic of the lower Abrigo Formation.

The Project area includes copper oxide and copper sulfide mineralization, and a transitional zone between these two zones that contains both oxide and sulfide mineralization. The top of the oxide zone coincides with the top of bedrock. Elevation contours for the top of bedrock are shown on Figure S-4. The thickness of the combined oxide and transition zones ranges from 50 feet to 1250 feet, but generally ranges from approximately 400 feet (north of I-10) to 850 feet thick within the Project area.

Mining operations will target the copper oxide mineralization, which occurs mainly as chrysocolla and/or malachite that has formed as coatings on rock fractures and as vein fill. Azurite and secondary chalcocite are also present. The remainder of the oxide mineralization occurs as replacement patches and disseminations.

Oxide copper also exists within the transition zone (between the oxide and sulfide zones). It mainly occurs along fractures and in quartz vein selvages as chrysocolla. Secondary supergene copper sulfide minerals such as chalcocite are often associated with the oxide mineralization in the transition zone. The transition zone is typically 100 to 200 feet thick. It is strongly fractured and broken similar to the oxide zone.

The oxide mineralization is predominately a flat blanket presumably hugging a paleo-water table. The mineralization is fairly uniform in distribution; however, there are some large higher grade 1% copper pods within the overall mineralized shell of oxidized copper mineralization.

Copper sulfide mineralization has formed preferentially in the proximal (higher metamorphic grade) skarn facies, particularly along stratigraphic units such as the Abrigo and Martin Formations and within structurally complex zones. Primary mineralization occurs as stringers and veinlets of chalcopyrite and bornite. Primary mineralization remains open at depth and to the north south, and east.

Oxide mineralization exhibits a high degree of fracturing and oxidation, whereas the sulfide mineralization is controlled by veining and alteration. Fracturing and faulting are best developed in terms of width and close spacing in a zone around the intrusive contact and this decreases away from the intrusive contact in the less altered rocks to the east. The initial formation of the skarn created denser minerals and removed CO_2, resulting in a volume reduction of the rocks, which in turn created significant fracturing, and therefore an increase of porosity and permeability allowing the later copper mineralization access. Weitz (1976) calculated a 30% volume reduction in the metamorphosed Abrigo and Martin formations in the Project area.

2.2.3 Amenability to Proposed Mining Method

ISR is the method chosen by Excelsior to extract copper from oxide mineralization located within the deposit. ISR is a feasible technology based on:

1. the fractured nature of the host rock (as documented in Attachment A),
2. the presence of water saturated joints and fractures within the ore body, and
3. copper mineralization that preferentially occurs along fracture surfaces.

The ISR method allows for operation in the vicinity of Interstate 10, and avoids the challenges of open pit mining in an area with basin fill overburden thickness ranging from approximately 300 feet to 800 feet.

The anticipated operational life of the Project is 23 years. Construction will begin upon issuance of applicable permits, subject to funding schedules. The target start date for production is mid~~dle to late~~ ~~2017~~2018.

3. TIME TABLE FOR PROPOSED DEVELOPMENT

Mine operations will be implemented in stages:

• Stage 1	Years 1 – 10	25 million pounds copper per year
• Stage 2	Years 11 – 13	75 million pounds copper per year
• Stage 3	Years 13 – 20	125 million pounds copper per year
• Post production	Years 20 – 23	--

The actual duration of each stage may vary, depending on economic conditions. Multiple mining blocks will be active during each stage. As mining of individual blocks is completed, the mining operations will be followed by a rinsing period while mining proceeds to subsequent blocks. The final rinsing period for the last mining block is anticipated to be completed by year 23.

4. PROPOSED AREA OF EXEMPTION

The extent of the proposed area of exemption coincides with the Area of Review (AOR) which has an irregularly-shaped boundary, as shown on Figure S-9. The AOR includes approximately 332 acres in Township 15 South Range 22 East Section 36 and Township 15 South Range 23 East Section 31. The AOR measures 3,630 feet from the northernmost to the southernmost point and 4,230 feet from the westernmost to the easternmost points. ~~The top of the aquifer exemption zone is proposed to be the top of bedrock, and the bottom of the aquifer exemption is proposed to be the top of the sulfide zone. The approximate elevations of top of bedrock and top of sulfide within the AOR are shown on Figure S-9. The elevation of the top of the exemption varies from approximately 4600 to 4000 feet above mean sea level. The elevation of the bottom of the exemption varies from approximately 3900 to 2400 feet above mean sea level. Actual depths will be refined as drilling progresses for installation of the wellfield.~~

Attachment D includes maps and cross sections that depict the vertical limits of underground sources of drinking water (USDWs) within the Area of Review (AOR) for which Excelsior is applying for an aquifer exemption. Figure D-1 shows the surficial geology of the Project area, Figure D-2 shows the bedrock surface geology, and figures D-3, D-4, and D-5 are cross sections through the AOR that show the vertical extents of the USDWs (shaded), the injection formation, and the direction of water movement.

The proposed aquifer exemption includes the following units within the AOR:

- Saturated Basin Fill (basin fill below an elevation of 4185 feet),
- Bedrock in the oxide zone (zone of injection),
- The top 200 feet of the sulfide zone,
- Tertiary quartz monzonite down to an elevation of 3100 feet above mean sea level (as shown on Figure D-5).

These units, with the exception of the oxide zone, are discussed in the sections below.

4.1 Saturated Basin Fill

A thin, isolated area of saturated basin fill (alluvium) exists below an elevation of 4185 feet within the AOR. This elevation is based on groundwater levels in NSH-006 and NSD-020, which are the only two wells screened solely in the basin fill. H&A (2015) reported that NSH-006 had 40 feet of saturated basin fill at the time it was installed. Recent water levels indicate approximately 30 feet of saturation at this well. Similarly, NSD-020 had 30 feet of saturated basin fill at the time of installation. Based on these observations, basin fill below an elevation of 4185 feet is considered a USDW and is included in the aquifer exemption. The interpreted extent of saturated basin fill is shown on Figure I-2 in Attachment I. ~~Excelsior is not requesting an aquifer exemption for the basin fill because the basin fill is not an aquifer. It does not meet the definition of an underground source of drinking water (USDW) according to 40 CFR §144.3. There are thin, isolated occurrences of saturated basin fill within the proposed AOR; thus, it does not contain a "sufficient quantity of groundwater to supply a public water system." These occurrences of saturated basin fill are discussed below.~~

~~The absence of significant amounts of saturated basin fill within the proposed AOR was documented by Haley & Aldrich (2015) during their hydrogeologic investigation of the Project. A copy of their report is provided in Exhibit S-2. Haley & Aldrich oversaw and documented the drilling and installation of 21 hydrogeologic wells and 5 piezometers in 2014-2015 (Figure S-4). Saturated basin fill was not observed in any of the boreholes within the AOR during this drilling campaign. Groundwater was encountered in bedrock fractures, often well below the basin fill-bedrock contact. After well completion in the bedrock, groundwater rose up into the cased section within the basin fill in some of the wells (NSH-014B, NSH-016, NSH-009). These groundwater levels represent a potentiometric surface, indicating confined conditions within the bedrock aquifer.~~

~~In 2011-2012, Excelsior initiated a six-well a drilling program to characterize the hydrogeology at the site. Saturated basin fill was identified in two boreholes within the AOR. Other wells were planned to be completed in the alluvium, but one well was dry, and three were cancelled when saturated alluvium was not observed during drilling of nearby bedrock wells.~~

~~The two wells (both shown on Figure S-4) in which saturated alluvium were identified were:~~

~~NSH-006 is screened within basin fill. H&A (2015) report indicates it had 40 feet of saturated basin fill; recent water levels indicate approximately 30 feet of saturation at this well.~~

~~NSD-020 had 30 feet of saturated basin fill at the time of installation.~~

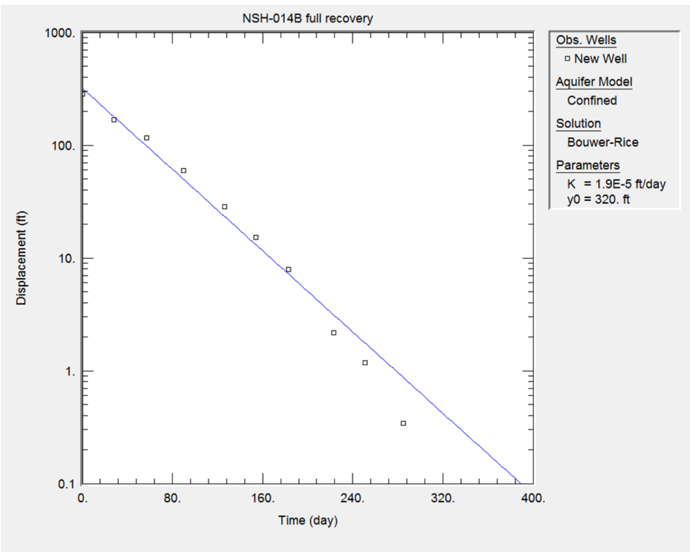
~~Both of these wells are within a low spot on the bedrock surface that appears to be constrained by the 4,200-foot bedrock surface contour.~~

4.2 Sulfide Zone

The top 200 feet of the sulfide zone is also proposed to be included in the aquifer exemption. While this zone is less fractured than the oxide zone, there is a possibility of fracture connection with the oxide zone that was not identified in the aquifer testing. As discussed in Attachment A-3, Excelsior conducted two aquifer tests, at NSH-014B and NSH-025, in the sulfide zone in 2015. Both tests were terminated before the scheduled end because the wells were pumped dry.

A complete analysis of the aquifer testing data is provided in Attachment A-3. Drawdown in NSH-014B was 442 feet after 1.5 hours at a pumping rate of one gpm. The estimated hydraulic conductivity for NSH-014B is 0.001 ft/day. Drawdown in NSH-025 was 220 feet after one hour with pumping at a rate of four gpm. The estimated hydraulic conductivity in NSH-025 is 0.03 ft/day (after re-analysis). Both hydraulic conductivity values measured in the sulfide wells are very low.

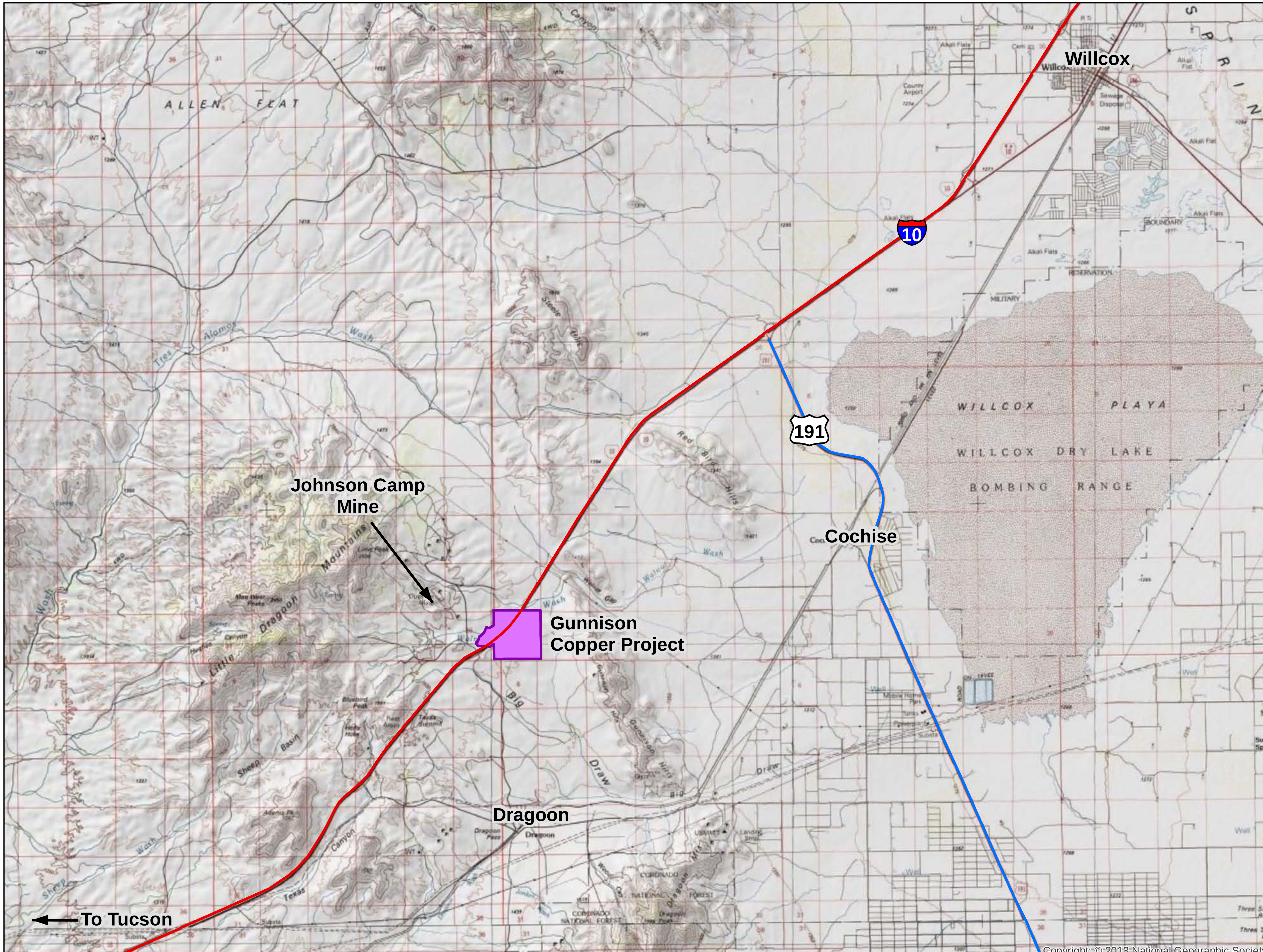
Full recovery of drawdown in well NSH-014B took in excess of 300 days. Because of the length of time required to fully recover, these data were not available at the time of permit application. The analysis of full recovery data from NSH-014B suggests a K value of 2e-05 ft/day when estimated with AQTESOLV (See Figure 16 from Attachment A-3 below).



4.3 Quartz Monzonite

The Texas Canyon Quartz Monzonite is present only in the southwest corner of the AOR (Figure S-8). It is proposed that the quartz monzonite within the AOR above an elevation of 3100 feet (as shown on Figure D-5) be included in the aquifer exemption for the same reason as the top portion of the sulfide zone is exempt. There may be some fracture connection with the oxide zone that was not identified by aquifer testing. In addition, there will be some injection within the zone because there is some oxide mineralization.

FIGURES



Legend

Gunnison Copper Project

0 1 2 4

Miles

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Gunnison Copper Project
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Date	File ID
1/19/16	373-008D

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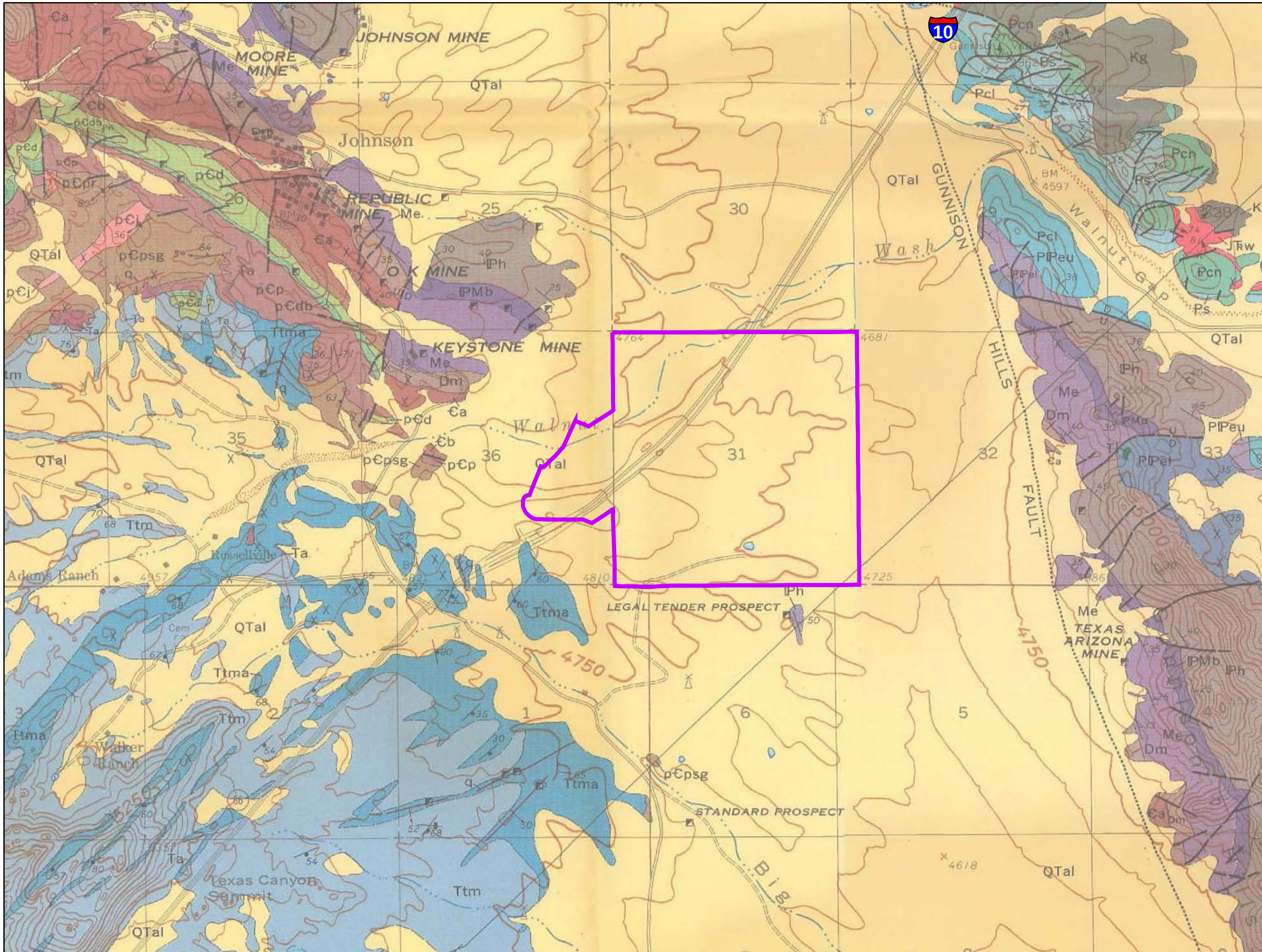
FIGURE S-1
Project Location



Legend

- Gunnison Copper Project
- QTal - Quaternary Alluvium (Basin Fill)
- Ttm - Texas Canyon Quartz Monzonite
- Ttma - Texas Canyon Quartz Monzonite (altered phase)
- jTrw - Walnut Gap Volcanics
- Pcn - Concha Limestone
- Ps - Scherrer Formation
- Pcl - Colina Limestone
- ℙpe - Earp Formation (ℙpeu, ℙpel)
- ℙh - Horquilla Limestone
- ℙmb - Black Prince Limestone
- Me - Escabrosa Limestone
- Dm - Martin Formation
- Ca - Abrigo Formation
- Cb - Bolsa Quartzite
- pCd - Dripping Springs Quartzite (Apache Group)
- pCp - Pioneer Shale (Apache Group)
- pCpsg - Pinal Schist

Geology reprinted from Cooper and Silver (1964)

0 1,000 2,000 4,000
Feet

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1/25/16	373-016E

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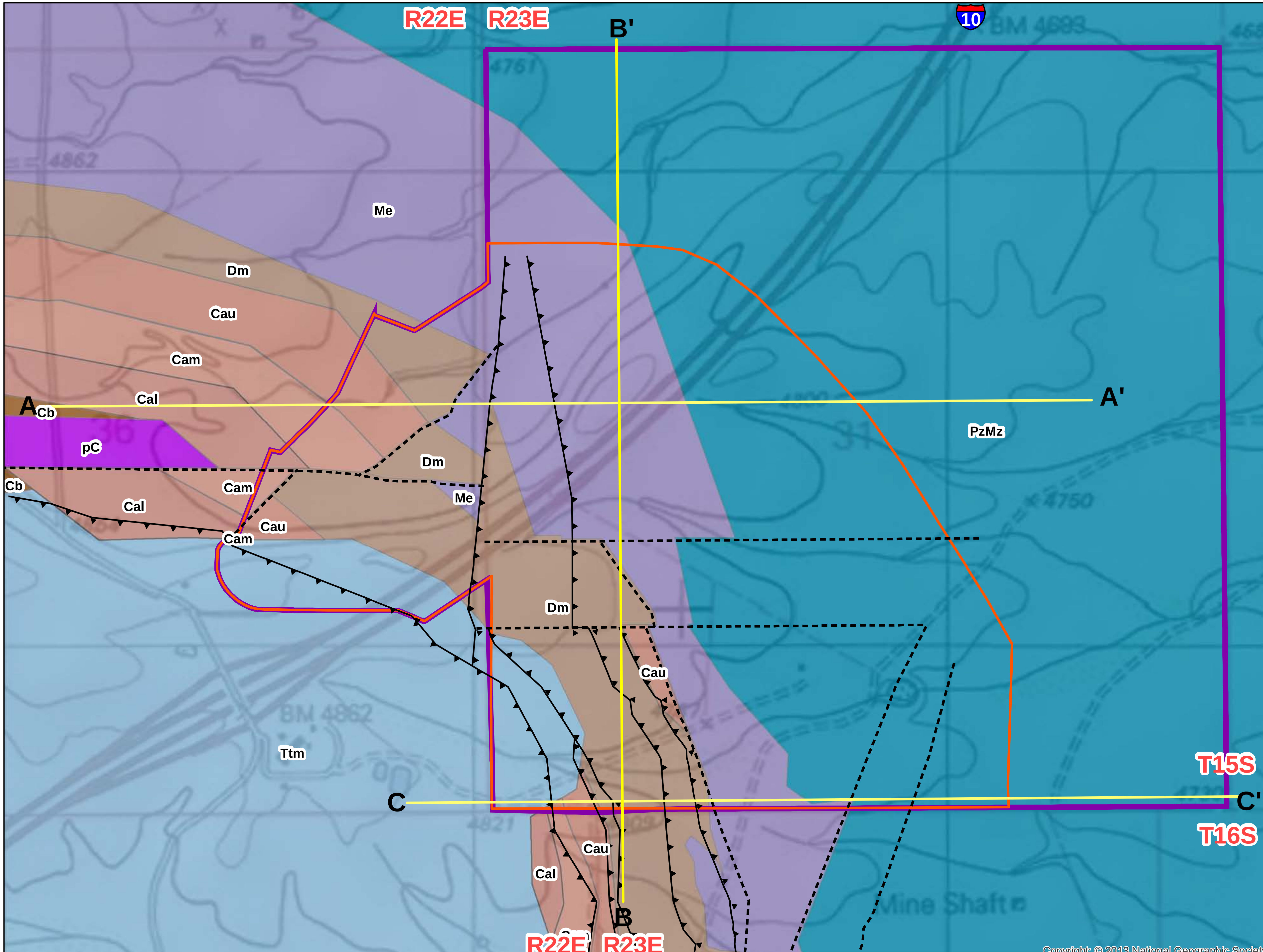
FIGURE S-2
Surficial Geologic Map



Legend

- Gunnison Copper Project
- Area of Review
- Cross Section Line
- Normal or Vertical Fault
- Thrust Fault
- Ttm - Texas Canyon Quartz Monzonite
- Me - Escabrosa Limestone
- Dm - Martin Formation
- Pz/Mz - Mesozoic/Palezoic Undivided
- Cal - Upper Abrigo
- Cam - Middle Abrigo Formation
- Cal - Lower Abrigo
- Cb - Bolsa Quartzite
- pC - PreCambrian Undivided

Source: Excelsior Geologic Model

0 350 700 1,400
Feet

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February 2016

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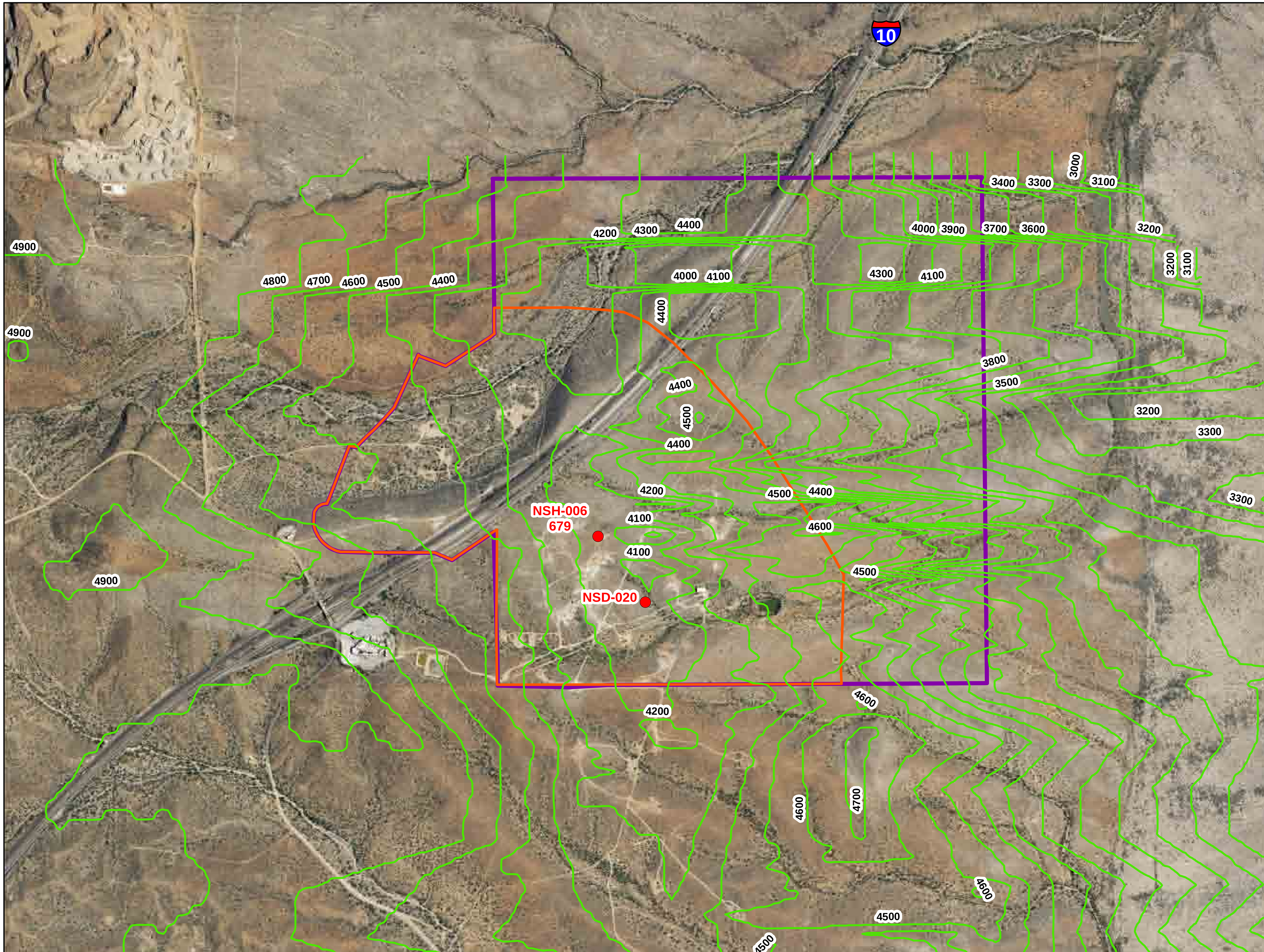
FIGURE S-3
Bedrock Surface
Geologic Map



Legend

Gunnison Copper Project

Area of Review

Bedrock Surface Elevation Contour (100 ft interval)

Well with Saturated Basin Fill (showing bedrock depth where known)

Source:
Excelsior Geologic Model

0 500 1,000 2,000
Feet

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1/25/16	373-020D

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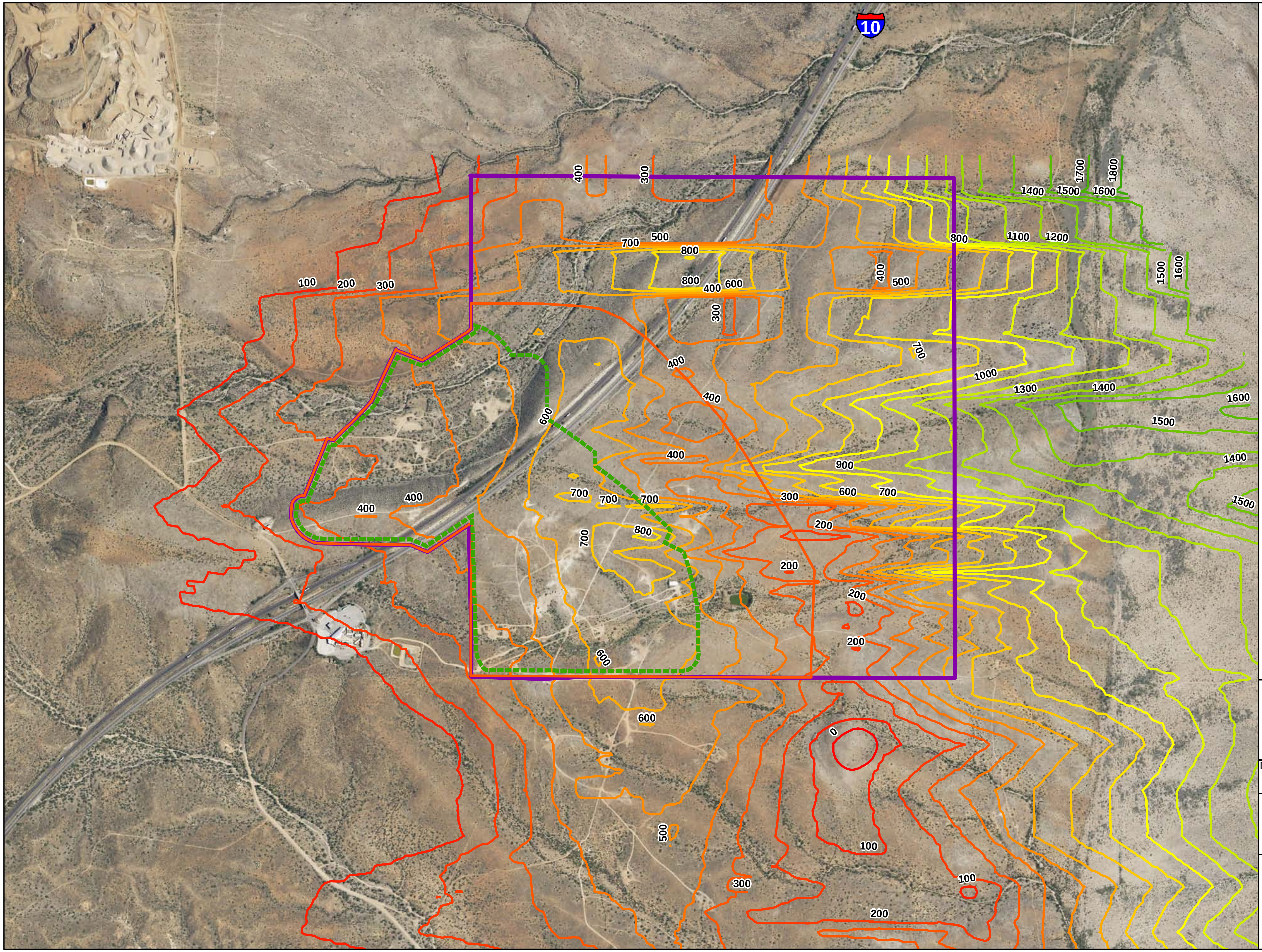
FIGURE S-4
Bedrock Elevation Contours



Legend

- Gunnison Copper Project
- Area of Review
- Wellfield

Alluvial Thickness (100 ft contour interval)

- 0
- 100
- 200
- 300
- 400
- 500
- 600
- 700
- 800
- 900
- 1000
- 1100
- 1200
- 1300
- 1400
- 1500
- 1600
- 1700
- 1800

Source: Excelsior Geologic Model

0 500 1,000 2,000
Feet

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Gunnison Copper Project
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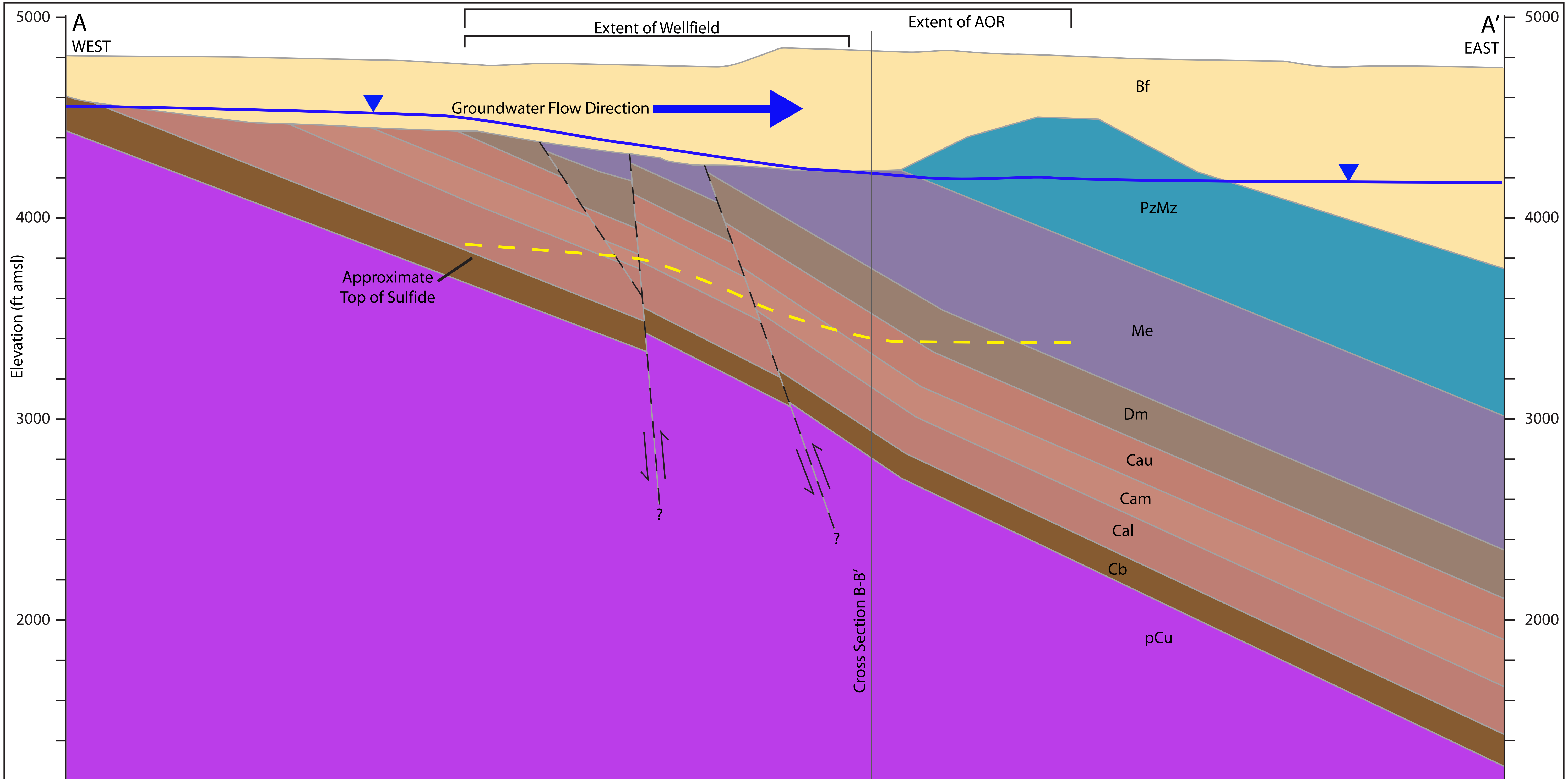
FIGURE S-5
Basin Fill Isopach
Map



Bf - Basin Fill
PzMz - Paleozoic/ Mesozoic Undivided
Me - Escabrosa Limestone
Dm - Martin Formation
Cau - Upper Abrigo Formation
Cam - Middle Abrigo Formation
Cal - Lower Abrigo Formation
Cb - Bolsa Quartzite
pCu - PreCambrian Undivided
Fault
Potentiometric Surface

0 500 1,000
Feet

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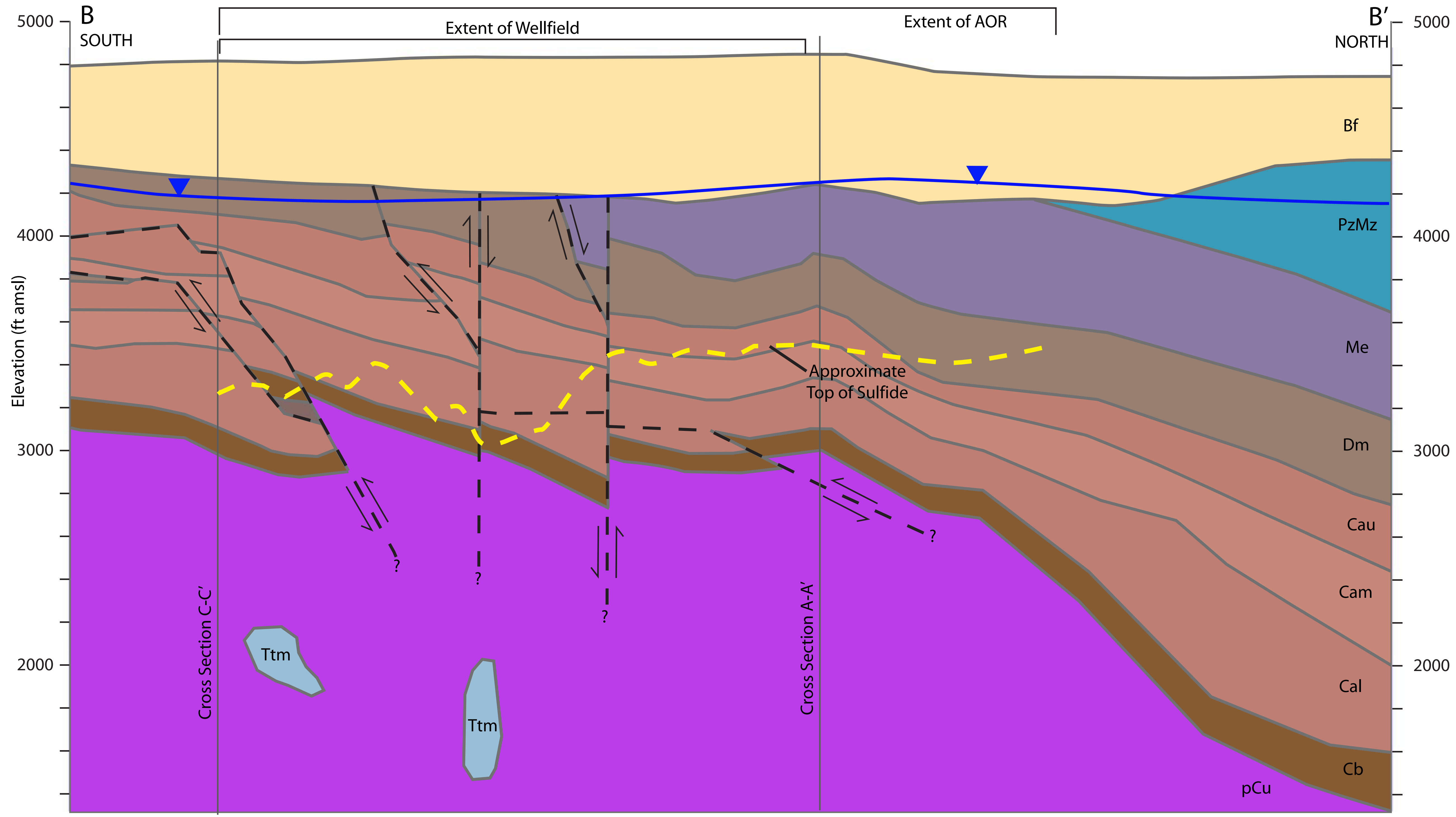
File ID	A373-010B

FIGURE S-6
Geologic Cross Section A - A'



Source: Excelsior Geologic Model

Bf - Basin Fill
Ttm - Texas Canyon Quartz Monzonite
PzMz - Paleozoic/ Mesozoic Undivided
Me - Escabrosa Limestone
Dm - Martin Formation
Cau - Upper Abrigo Formation
Cam - Middle Abrigo Formation
Cal - Lower Abrigo Formation
Cb - Bolsa Quartzite
pCu - PreCambrian Undivided
Fault
Potentlometric Surface

0 500 1,000
Feet

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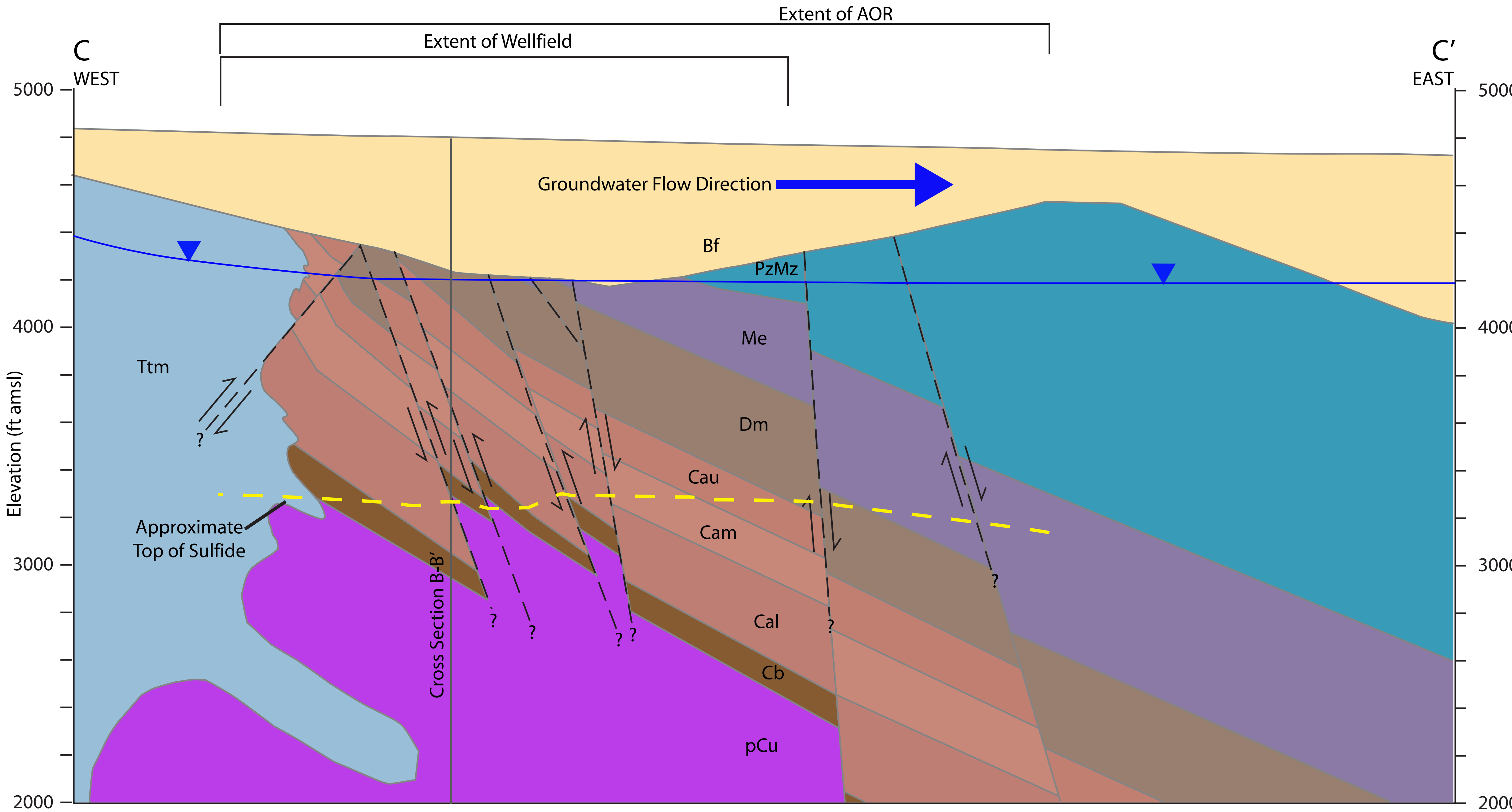
File ID A373-011B

FIGURE S-7
Geologic Cross Section B-B'



Source: Excelsior Geologic Model

Bf - Basin Fill
Ttm - Texas Canyon Quartz Monzonite
PzMz - Paleozoic/ Mesozoic Undivided
Me - Escabrosa Limestone
Dm - Martin Formation
Cau - Upper Abrigo Formation
Cam - Middle Abrigo Formation
Cal - Lower Abrigo Formation
Cb - Bolsa Quartzite
pCu - PreCambrian Undivided
Fault
Potentiometric Surface

0 500 1,000
Feet

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FIGURE S-8
Geologic Cross Section C - C'